

## Colloids and Plant Nutrients

### Colloids

Graham was the first man who introduced the term colloids in 1849.

A Colloid may be defined as a substances in a particularly fine state of subdivision, dispersed in another continuous medium giving raise to a large increase in surface area of the dispersed phase.

Thus Colloids are 2 phase heterogeneous system. The dispersed phase and the dispersed medium. e.g. clay, milk, gum, blood etc.

### Classification of Colloids

Colloids may be classified in different ways as follows-

1. According to ***affinity of dispersed phase towards dispersed medium***, Colloids may be-
  - A) Layophobic/ Hydrophobic colloids. e.g. metal, gold, sulphide salt etc.
  - B) Layophilic. e.g. clay minerals, gelatin, gum etc.
2. According to ***particle shape***, colloids may be-
  - A) Sphero colloids. e.g. Glycogen.
  - B) Linear colloids. Rubber, PVC.
3. According to ***chemical composition***, colloids may be-
  - A) Inorganic or mineral colloids. e.g. clay mineral,  $\text{Fe(OH)}_2$  etc.
  - B) Organic colloids. e.g. humus, protein etc.
4. According to ***structure***, colloids are 2 types-
  - A) Molecular colloids (macro). e.g. starch, cellulose etc.
  - B) Micellar colloids (micro). e.g. Soap, emulsion etc.

## Properties of Colloids

properties of colloids are listed below-

1. Particle size.
2. Surface area.
3. Surface charge.
4. Adsorption of cations and anions.
5. Adsorption of water.
6. Heterogeneity.
7. Osmotic pressure.
8. Filterability.
9. Faraday tyndall effect.
10. Colour.
11. Brownian movement.
12. Cataphoresis/ electrocataphoresis.
13. Electro osmosis.
14. Isoelectric point.
15. Coagulation.
16. Adsorption.
17. Zeta potential/ electrostatic potential.
18. Thermodynamic potential.

## Ion uptake

**Mechanism:** Ion uptake mechanism is a two way processes-

Step- 1: The first step of the ion uptake by the growing plants is the Adsorption of ions by the Ca-pectate layer of the cell wall of roots and then cytoplasm.

Step- 2: The second phase of ion uptake mechanism is the transfer of adsorbed ions through cytoplasm and into the cell sap. This process occurs, where metabolic energy is required. The metabolic energy is produced from respiration and the ion transformation occurs against osmosis.

## Principles

1. Plants uptake nutrients cation (+) in exchange of  $H^+$  excreted by plant roots.
2. Plants uptake nutrients anion in exchange of  $HCO_3^-$  excreted by plant roots.

## Ion Transport Mechanism

The dissolved nutrients in the soil solution have to come in contact with plant roots for absorbing by plant. Following 3 mechanisms / ways by which nutrients come in contact with plant roots are-

1. Mass flow.
2. Diffusion.

3. Root interception.

**1. Mass flow:** mass flow is occurred when soil water contains nutrients ion. Mass flow is the process in which the ions of plant nutrients elements in soil move to the plants with water flow. Water flow is produced by transpiration in plants and nutrient ion and dissolved food materials are moved through water. It can be expressed by following formula-

$$Q = V \times C$$

Here,

$Q$  = mass flow rate.

$V$  = water flow rate.

$C$  = Ionic concentration in soil solution.

Ca, Mg, S, N and most of micro nutrients move to the plants by mass flow.

**2. Diffusion :** By the action of thermal flow, diffusion occurs when ion moves from an area of higher concentration to the area of lower concentration. It happens without movement of soil water. Mass flow and diffusion occur simultaneously.

Specially, K and P move to plant roots by diffusion. Factors influencing in mass flow and diffusion flow are given below-

***Soil texture***- If it is sandy soil, mass flow and diffusion occur limit but in clay soil is more.

***Soil moisture***- If it is high moisture, the mass flow and diffusion should be low.

***Soil temperature***- In Low temperature movement is low, In Warm temperature movement is high.

**3. Root interception :** While the root system of plants spread out in soil, the structure of soil destroyed. As a result, soil solution and adsorbed ions of its surface come in contact to the root surface. Finally, ions are absorbed in roots by contact exchange theory.

### Role of clay colloids in plant nutrients

1. Leaf without colloid.
2. Soil solution.
3. Exchangeable ions on the surface of clay and humus.
4. Rapidly decomposed mineral.

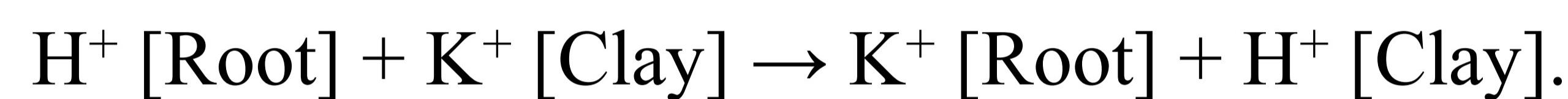
## **Ion Uptake Theory**

Scientists have postulated many theories about adsorption of ions, among them following 2 are most important -

1. Contact exchange theory.
2. CO<sub>2</sub> exchange theory.

### **1. Contact exchange theory**

In 1951 aenni and his associates develop this theory. This is a process of direct ion exchange between root cells and soil colloids. They observe that cations of soil colloids are generally moving around their own shell and similarly H<sup>+</sup> ions of root surface are also moving around their own shell. In this process, once upon a time when two shells are come in contact closely they overlap each other. Then the ions of these two shells, exchange each other. Result by, H<sup>+</sup> ions are replaced by other cations.



### **2. CO<sub>2</sub> exchange theory**

Walker 1960 differed with Gennis contact exchange theory. According to his theory, he says, plant roots uptake cation and anion in the exchange of H<sup>+</sup> and OH<sup>-</sup> ions from soil solution respectively. The following steps are associated with CO<sub>2</sub> exchange theory.

**Step-1 :** After respiration of plant roots and soil micro organism CO<sub>2</sub> is produced. By the reaction of CO<sub>2</sub> with H<sub>2</sub>O, H<sub>2</sub>CO<sub>3</sub> acid is produced.

**Step- 2 :** By the dissociation of H<sub>2</sub>CO<sub>3</sub> acid ions pairs of H<sup>+</sup> and HCO<sub>3</sub><sup>-</sup> are produced and these ion pairs transfer/ locate into a clay surface area of long distance.

**Step- 3 :** Cations like K<sup>+</sup> is replaced by H<sup>+</sup> from clay surface and produce the ion pairs HCO<sub>3</sub><sup>-</sup> and K<sup>+</sup> and the clay particles become acidic.

**Step- 4 :** These new ion pairs return to the surface of root which is easily available for plants.

**Step-5 :** K<sup>+</sup> or HCO<sub>3</sub><sup>-</sup> both enter into the plant roots with the exchange of H<sup>+</sup> of root surface area.

## Plant Nutrients

Elements absorbed from the soil by the roots are generally known as plant nutrients.

Name	Available form	Sources
Carbon (C)	$\text{CO}_2$	Air
H	$\text{H}^+$ , $\text{H}_2\text{O}$	Water
O	$\text{O}_2^-$ , $\text{OH}^-$	Air
N	$\text{NH}_4^+$ , $\text{NO}_3^-$	Air fertilizer
P	$\text{H}_2\text{PO}_4^-$ , $\text{HPO}_4^{2-}$ , $\text{PO}_4^{3-}$	Soil, fertilizer
K	$\text{K}^+$	Soil, fertilizer
S	$\text{SO}_4^{2-}$ , $\text{SO}_2$	Soil, fertilizer
Ca	$\text{Ca}^{2+}$	Soil, lime
Mg	$\text{Mg}^{2+}$	Soil, lime
Fe	$\text{Fe}^{2+}$ , $\text{Fe}^{3+}$	Organic matter, soil
B	$\text{H}_2\text{BO}_3^-$ , $\text{HBO}_3^{2-}$ , $\text{BO}_3^{3-}$	Fertilizer
Mn	$\text{Mn}^{2+}$ , $\text{Mn}^{4+}$	Fertilizer
Cu	$\text{Cu}^+$ , $\text{Cu}^{2+}$	Fertilizer
Zn	$\text{Zn}^{2+}$	Fertilizer
Mo	$\text{MnO}_4^{2-}$	Fertilizer
Cl	$\text{Cl}^-$	Fertilizer

The form in which nutrients are available to plants is called available form.

### Criteria of Essential plant nutrients

1. In the absence of an elements, the plant cannot complete their life cycle.
2. An elements can not be replaced by another.
3. The elements is directly involved in nutrition of the plant.